REMARKS

Claims 35, 37-41, 46, 49, 51 and 62-63 are amended herein. The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

REJECTION UNDER 35 U.S.C. § 112

Claims 38-41 and 63 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point and distinctly claim the subject matter which Applicant regards as the invention. This rejection is respectfully traversed.

The Examiner has rejected to claims 38-41 and 63 as being indefinite. Claims 38 and 63 have been amended to recite a range for each of the components within the MS-51 formulation such that the original limits are recited with the clarification that the tetramethoxysilane and methanol must be present in an amount greater than 0% to address the Examiner's initial objection. In light of the amendments the Applicant considers the rejections relating to indefiniteness have been overcome.

REJECTION UNDER 35 U.S.C. § 103

Claims 35-38, 41-51 and 62-63 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Floch (U.S. Patent No. 5,698,266) in view of Nambu (U.S. Patent No. 6,316,572). This rejection is respectfully traversed.

Claim 35, as presently amended, recites the steps of (i) producing a silica precursor solution having a water content of no more than 5% by volume by dissolving silicic acid tetramethyl ester homopolymer in a solvent; (ii) coating a substrate with the silica precursor solution; and (iii) curing the silica precursor solution onto the substrate in a vaporous ammoniacal environment. The present amendment makes it clear that

this is not a sol-gel process and the silica source is to remain in solution even when it is deposited on the substrate up to the point of exposure to the ammoniacal environment.

Floch discloses a slight modification to traditional sol-gel techniques for producing thin films of optical quality using silica colloids. The process taught by Floch is to produce a fully hydrolysed silica colloid in alcohol which is then applied to a substrate.

Example 1 of Floch teaches the formation of a colloidal suspension of distilled tetraethyl orthosilicate (TEOS) in ethanol by addition of an ammonia solution to bring about hydrolysis of the TEOS in the ethanol. This leads to an "opalescence revealing the formation of silica colloids." Floch then discusses various physical aspects of the colloid. Floch also describes how the silica sol is deposited onto the substrate and dried before subsequently being exposed to an ammoniacal atmosphere. In other embodiments (column 4, lines 50-54 and Fig. 4) Floch teaches the immersion of the dried sol on the substrate in a volume of an ammonia solution rather than merely exposing to an ammoniacal atmosphere. This is possible with the method of Floch because it forms a colloid which is deposited onto the substrate and then dried to yield a layer of solid particles on the substrate. The particles are non-soluble and hence are stable under exposure to a liquid alkaline environment.

This is in direct contrast to the present method, as defined in amended claim 35, whereby a solution of the silica source in a solvent is formed and it is this solution which is directly applied to the substrate. As is set out in amended claim 35, it is the "silica precursor solution" which is cured onto the substrate by exposure to the vaporous ammoniacal environment. In other words, formation of a colloid or deposition of solid

particles is avoided and the solution is not dried on the substrate before exposure to ammonia, as required by Floch. Drying the present coating after deposition (if following the method of Floch) would remove the solvent leaving only liquid MS51/ silicic acid tetramethyl ester homopolymer on the substrate. This would not be capable of forming a stable continuous film with controlled porosity as the control of the rate of hydrolysis and condensation reactions, which are facets of the present process, specifically rely upon solvent being present immediately prior to the curing phase. With this response, Applicant submits the Declaration Under 37 C.F.R. 1.132 of Dr. Michael Harvey ("Harvey Decl.") in support of these conclusions.

By way of supporting information an experimental process was conducted where a silicic acid tetramethyl ester homopolymer solution was deposited on a glass substrate via dip coating, as described in the present application. *See*, Harvey Decl. ¶8. The coated article was then allowed to dry in the manner described in Floch (col. 6 lines 55-56). *Id.* Subsequently the transmittance of the coated article was measured to be ~90% at 1000nm (c.f. Floch T=95.4% at 1000nm col. 6 line 60), and the refractive index of the coating was determined to be 1.39 (c.f. Floch n=1.22 col. 6 line 61-62). *Id.* For reference, a refractive index of ~ 1.4 would suggest a dense silica layer and therefore not porous. *Id.* This data clearly shows that there is no layer of particles formed when an alcohol/MS-51 solution is used according to Floch's process. *Id.* at ¶ 9. This result is not surprising as the silica precursor solution of the present process is not a colloid as Floch's process requires. *Id.*

Thus, the process taught by Floch ensures that all hydrolysis of the silica source is complete before deposition and that the porosity in the final film is present at the time

of drying due to the random packing of silica particles. *Id.* at ¶10. The present process, by contrast, does not produce any solids until exposure to the curing environment and relies on those alkaline conditions to induce a phase separation which will assemble and template the film's final porosity. *Id.* at ¶12. This can be controlled because of the self-limiting nucleation, growth and chemical sintering of the particles from the continuous phase. *Id.*

Floch observes that, post deposition, changes in the coating thickness do not have any effect on the film porosity or refractive index (col.5 lines 36-38). *Id.* at ¶11. Floch goes on to point out that this is only consistent with one possible interpretation: the coated layer is formed of silica colloid particles whose surfaces are hydroxylated. *Id.* The alkaline treatment of Floch thus condenses the surface silanols binding the particles together (col.5 lines 43-54). *Id.*

In summary, even if MS-51 from the process of Nambu were to be substituted into the process of Floch, the key steps of the present process, as defined by claims 35 and 62, would still not be taken since the process of Floch would result in early hydrolysis to form a colloid prior to deposition on the substrate whereas amended claims 35 and 62 require that the silica source be maintained as a solution in the solvent until exposure to an ammoniacal environment after deposition on the substrate. *Id.* at ¶13. This reflects the fact that the process of Floch (sol-gel) and the present process (phase-separation templating) follow entirely different pathways. *Id.* at ¶7. The present process allows for morphology control over film pore size which could not have been predicted or even inferred from the process of Floch and is non-obvious over that teaching. *Id.*

The Applicant also respectfully submits that it would not have been obvious to a person of skill in the art to look to the use of MS-51 in the process of Nambu for an alternative silica source to introduce into the process of Floch. Nambu discloses a multi-component composition for producing coatings with good weather resistance and appearance. The composition contains three essential components: A – a resin with epoxy and carboxyl moieties; B – a vinyl copolymer which contains at least one hydrolysable silyl group; and C – a silicon compound containing hydrolysable groups which is included to improve stain resistance. The multi-component system also contains a 4th set of compounds, namely D – a curing catalyst. It should be understood that Nambu employs MS51 purely as a filler and to improve the stain resistance of resin films. It is components A and B which form the backbone of the resin film itself. It does not appear obvious that a single component of a multi-component mixture disclosed by Nambu et al. only as being useful for improving stain resistance would be suitable for use, on its own, in forming transparent optical silica films.

There is no disclosure in Nambu which predicts or suggests the use of MS-51 to form a self-assembled porous structure or the use of a phase-separation templating method, as employed in the present process, to create controlled morphology in an optical film. Neither is there anything in Nambu et al. which leads one to the conclusion that, when employing a silica source such as MS-51, control over reaction conditions can be used to engineer morphology in a specific fashion nor create a porous network that is structurally robust without the need for thermal sintering of the resultant silica network. The Applicant therefore respectfully submits that the present claims are non-obvious in view of Floch alone or in combination with Nambu.

The Examiner also comments that "it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the process of [Floch] by adding some amount of water to accelerate hydrolysis reactions to form the sol within the spirit of the invention." As discussed above and defined in the amended claims, at no time in the present process is a colloidal suspension formed. The present process uses the ammoniacal gas environment, after deposition on the substrate has occurred, to drive both hydrolysis and condensation reactions causing micro phase separation of the deposited solution. This phase separation results in self assembly of the system into a porous solid and the growth of particles in the continuous phase constitutes a self limiting chemical sintering process. The traditional sol-gel pathway is expressly avoided as it does not provide the desired end product and this is now clearly defined within the claims.

For all of the foregoing reasons, the Applicant respectfully submits that independent claims 35 and 62, and all claims dependent thereon, patentably define over the prior art cited. Accordingly, Applicant looks forward to favorable reconsideration.

CONCLUSION

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action and the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner

believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

/ David A. McClaughry /

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David A. McClaughry
Reg. No. 37,885

HARNESS, DICKEY & PIERCE, P.L.C.
P.O. Box 828
Bloomfield Hills, Michigan 48303
(248) 641-1600

DAM/pal

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